HORT & CROP SCIENCE SERIES NO. 720 JANUARY, 2002

VEGETABLE RESEARCH RESULTS 2001

Mark A. Bennett
Elaine M. Grassbaugh
Andrew F. Evans
Matt Hofelich
Roseli Caseiro
C. Andy Wyenandt
R. Mac Riedel

The Ohio State University
Department of Horticulture and Crop Science
Columbus, OH

Ohio Agricultural Research and Development Center

This page intentionally blank.

INDEX

This page intentionally blank.

INTRODUCTION

This report summarizes the results of several vegetable studies conducted during 2001. Weather data for the 2001 growing season is included at the end of this report.

The excellent cooperation of Don Burgess, Sean Mueller, Chris Rettig, Mark Schmittgen, Darren Johnson and Ken DeWeese is greatly appreciated. We hope that this type of information is of benefit to the vegetable industry in Ohio and the Great Lakes region. Your comments and suggestions for future efforts are always welcome.

Dr. Mark Bennett
Professor
Dept of Horticulture and Crop Science
The Ohio State University
312A Kottman Hall
2021 Coffey Road
Columbus, OH 43210
phone: 614/292-3864
FAX: 614/292-7162
email: bennett.18@osu.edu

Elaine M. Grassbaugh
Research Associate
Dept of Horticulture and Crop Science
The Ohio State University
303 Kottman Hall
2021 Coffey Road
Columbus, OH 43210
phone: 614/292-3858
FAX: 614/292-7162
email: grassbaugh.1@osu.edu

ACKNOWLEDGMENTS

Our thanks to the following organizations who provided funding for these projects:

- *Pickle Packers International, Inc.*
- *Mid-America Food Processors Association*
- *The Ohio Vegetable and Small Fruit Research and Development Program*
- *USDA/SARE*
- *OARDC Graduate Research Program*

Appreciation is extended to the following who provided seed, transplants, or other supplies for these projects:

- *Abbott & Cobb*
- *Crookham Company*
- *Harris Moran*
- *Rispens Seeds, Inc.*
- *Seedway, Inc.*
- *Seminis*
- *Siegers Seed Company*
- *Stokes Seeds, Inc.*
- *Syngenta Seeds, Inc.*
- *Dr. David Francis*

This page intentionally blank.

Paclobutrazol Seed Soak for Height Control in Processing Tomato Height Control and Improved Crop Production - 2001

Mark A. Bennett, Elaine Grassbaugh, Andy Evans and Matt Hofelich
The Ohio State University
Dept. of Horticulture and Crop Science, 312A Kottman Hall,
2021 Coffey Rd.,
Columbus, OH 43210

Introduction:

Stretching and legginess in processing tomato transplants becomes a problem when field planting in the spring is delayed due to weather conditions. Increased internode length and thin, weak stems can also be caused by cloudy or warm weather during transplant production. Difficulties in mechanical transplanting and field survival are challenges that processing tomato growers face with increased transplant heights. Preliminary work in 2000 at OSU on processing tomatoes suggests a stockier, shorter transplant can be produced with the use of the growth regulator paclobutrazol (Bonzi™) as a seed soak prior to sowing (Appendix 1). Paclobutrazol acts by inhibiting gibberellin biosynthesis, which is involved in seedling elongation. Specific objectives of our 2001 research were (1) to compare several concentrations of Bonzi™ used as a seed soak prior to sowing into plug trays, and (2) to determine any subsequent effects in the field on flowering and or/time to harvest, yield, and fruit characteristics.

Methods and Materials:

Tomato seeds ('OX150') were soaked in paclobutrazol solutions at 0, 500 and 1000 ppm for 6 or 16 hours. Seeds were dried back for at least 16 hours at 25° C before sowing into 200-cell plug trays. Transplant height measurements and survival were recorded at 14, 21, 28 and 35 days after seeding (DAS). On June 11, 2001 transplants were established in the field at the Veg Crops Branch (Fremont, OH) in a randomized complete block design with 3 replications of each concentration/seed soak treatment. Standard production practices for the Midwest U.S. (disease/insect management, fertilizer rates, weed control, etc.) were followed. Plant height, internode length and stem diameter were measured at field transplanting and one month after field establishment. Data collected at time of mechanical once-over harvest on October 2, 2001 includes final yield of marketable reds, greens & culls. Average fruit size was also determined.

Results and Discussion:

Transplant height was reduced with a Bonzi™ seed soak prior to sowing into plug trays. At 35 DAS, there was a significant difference in transplant height when seeds were soaked in either concentration (500 ppm, 1000 ppm) of Bonzi™ (Table 1). Emergence at 35 DAS showed a significantly lower emergence rate with Bonzi™ treatments of 1000 ppm. One month after field establishment, there were no significant differences in plant height, internode

length or stem diameter measurements among all treatments. At harvest, there were no significant differences in T/A of marketable fruit or percent red fruit at harvest. This suggests that Bonzi™ soaked seed can produce shorter transplants without adverse effects on final marketable yield (Table 1). These results are consistent with results from 2000 field research.

Future work is warranted in investigating different concentrations and shortersoak times that will produce shorter transplants while achieving maximum seed germination/transplant establishment. More cultivars should also be tested.

Acknowledgment:

We would like to thank *Mid-America Food Processors Association* for their financial support of this project.

Appendix 1. **Paclobutrazol Seed Soak for Height Control in Processing Tomato Transplant Production - 2000 (Veg Crops Branch, Fremont, OH)**

Cultivar: 'OX150'

Treatment	10 DAP Ht (cm)	10 DAP % germ	14 DAP Ht (cm)	14 DAP % germ	21 DAP Ht (cm)	21 DAP % germ	28 DAP Ht (cm)	35 DAP Ht (cm)	At transplant (8 wks. after seeding) Ht. (cm)	% germ	Internode length (cm)	Stem diam. (mm)
Dry seed control	2.5	88	2.5	95	5.6	95	15.8	19	20.1	95	3.5	3.4
Water soak - 6 hrs	2.1	89	2.7	90	5.0	91	14.6	19	20.1	91	2.6	3.3
500 ppm - 6 hrs.	1.4	43	1.9	86	3.8	90	8.6	11	14.0	90	1.3	4.1
1000 ppm - 6 hrs.	1.5	35	1.6	83	2.5	86	7.3	11	12.9	86	0.8	4.3
Water soak - 16 hrs.	2.4	92	2.8	94	5.7	94	15.0	17	20.2	94	2.7	3.4
500 ppm - 16 hrs.	1.6	57	1.8	89	3.0	92	8.2	11	12.1	92	0.9	4.3
1000 ppm - 16 hrs.	1.4	53	1.9	90	3.7	91	8.0	11	12.2	91	0.8	4.7
LSD (0.05)	0.16	13.3	0.22	5.9	0.30	5.1	1.23	1.0	1.98	5.1	0.74	0.26
CV	25.7	35.9	21	5.4	29.0	4.2	33.3	26.1	24.3	4.2	61.5	13.9

Treatment	1 month after tranplant - Plant ht. (cm)	Stem diam (mm)	Internode length (cm)	Yield - Red T/A	Green T/A	Cull T/A	Avg. fruit size (oz.)	Percent red
Dry seed control	39.6	6.9	7.3	23.2	3.2	3.1	2.3	80
Water soak - 6 hrs	38.8	7.3	7.6	28.6	3.2	1.2	2.2	86
500 ppm - 6 hrs.	41.4	7.1	7.3	29.9	2.7	1.5	2.3	88
1000 ppm - 6 hrs.	41.1	7.3	7.2	32.9	3.0	1.2	2.2	89
Water soak - 16 hrs.	35.8	7.2	7.0	27.0	3.2	1.0	2.3	87
500 ppm - 16 hrs.	39.0	7.2	6.9	28.4	2.5	0.6	2.3	90
1000 ppm - 16 hrs.	39.9	7.5	7.0	24.3	2.5	1.0	2.0	86
LSD (0.05)	NS	NS	0.35	NS	NS	NS	NS	NS
p value	0.154	0.251		0.175	0.917	0.362	0.596	0.068
CV	6.7	4.2	4	27.9	47.6	96.5	12.4	50.0

Table 1. Paclobutrazol Seed Soak for Processing Tomato Transplant Height Control and Improved Crop Production- 2001
Veg Crops Branch, Fremont, OH

Cultivar: 'OX150'	14 DAS*		21 DAS*		28 DAS*		35 DAS*		At transplant (7 weeks after seeding)*		
Seed soak	% emergence	Plant ht (cm)	% emergence	Plant ht (cm)	% emergence	Plant ht (cm)	% emergence	Plant ht (cm)	Plant ht (cm)	Internode length (cm)	Stem diam (mm)
Dry Control	60	5.4	66	8.9	66	18.0	66	24.7	33.2	3.6	4.15
Water - 6 hrs.	77	4.8	77	9.1	77	18.0	77	23.3	37.6	3.6	3.93
Water - 16 hrs.	76	5.9	77	11.2	77	19.9	77	24.5	31.1	3.7	5.30
500 ppm - 6 hrs.	65	3.1	70	6.6	70	13.7	70	22.7	34.0	4.0	5.43
500 ppm - 16 hrs.	65	3.0	65	6.6	67	14.3	66	20.1	24.5	2.0	4.93
1000 ppm - 6 hrs.	62	3.4	61	6.6	61	15.8	61	20.1	23.8	2.5	4.14
1000 ppm - 16 hrs.	41	3.4	51	6.1	51	14.7	51	20.6	21.4	2.5	5.32
LSD	13.15	0.49	14.65	0.75	14.87	0.92	14.65	1.48	3.07	0.4	0.64
p value											
CV	21.6	28.3	18.4	23.5	18.5	13.9	18.4	9.5	20.4	24.8	14.5

	One month after transplant**			Yield**				
Seed soak	Plant ht (cm)	Internode length (cm)	Stem diam (mm)	Red T/A	Green T/A	Culls T/A	Avg fruit size (lbs)	Percent red
Dry Control	33.7	4.7	8.3	29.1	11.3	4.0	0.12	72
Water - 6 hrs.	35.0	3.5	8.8	29.2	10.7	4.1	0.12	73
Water - 16 hrs.	37.9	3.5	9.6	26.5	13.7	3.0	0.13	66
500 ppm - 6 hrs.	37.1	3.6	9.1	23.5	10.0	4.1	0.13	71
500 ppm - 16 hrs.	37.0	4.1	8.7	29.4	7.5	4.2	0.14	79
1000 ppm - 6 hrs.	36.7	3.7	8.9	29.0	10.0	3.6	0.12	75
1000 ppm - 16 hrs.	36.1	3.3	9.2	26.9	11.1	4.4	0.12	71
LSD	NS	NS	NS	NS	NS	NS	0.02	NS
p value	0.832	0.307	0.350	0.442	0.382	0.528		0.326
CV	9.3	19.8	7.7	13.5	28.6	20.8	5.1	8.9

* = data based on 4 replications

** = data based on 3 replications

Yield and Disease Control in Fresh Market Tomato as Affected by Paclobutrazol and Biocontrol Agents.

Surabhi Dikshit, Mark Bennett, Bob Precheur, R. Mac Riedel* and Matt Kleinhenz
The Ohio State University, Dept. of Horticulture & Crop Science and *Dept. of Plant Pathology.

Introduction

Vegetable growers face challenges in producing good quality and healthy transplants. Excessive elongation in transplants grown for vegetable crops is a major concern. Legginess makes transplant handling difficult and thus leads to losses, especially if field planting is delayed due to poor weather. Several studies done on vegetables, ornamentals and oilseed crops show that paclobutrazol (plant growth regulator with strong anti-gibberellin activity) reduces plant height (Setia et al. 1995; Latimer 1992; Pasian and Struve 2000; Souza-Machado et al. 1999; Nishizawa 1993), gives significantly improved seedling drought tolerance (Souza-Machado et al., 1999) plus improves field establishment and shoot dry weight gain (Mc Kee, 1981). This experiment studies the use of paclobutrazol on fresh market tomato while also using the transplant production phase to introduce biocontrol agents with antagonistic properties against *Phytopthora spp.* causing Buckeye Rot. Most of the studies which demonstrate that biological controls are effective, have been conducted in pots in greenhouses. Due to several reasons the results obtained in such studies fail to remain consistent when applied in the field conditions. This may be because of long periods between planting and disease development, failure of biocontrol microflora to colonize and compete with other soil microflora, and because cultural and edaphic factors may intervene to suppress development of biocontrol agents or enhance development of pathogen. During transplant production phase in the greenhouse we have tried to incorporate commercial biocontrol agents into the root zone of tomato seedlings.

Objective

This study aims to determine any difference in the transplant quality and yield of fresh market tomato (cv. 'Early Cascade') treated with paclobutrazol and biocontrol agents namely Companion™ a.i *Bacillus subtilis* GBO3 (Growth Products, White Plains, NY, U.S.A) and Mycostop™ a.i *Streptomyces gresioviridis* K61 (AgBio Development Inc., Westminster, CO, U.S.A).

Materials and Methods

Tomato seed, ('Early Cascade'), was soaked in 500ppm of paclobutrazol and water for 6h followed by a 16h drying period before planting in plug trays. After 3 weeks in the greenhouse, the first drench application of two commercial biocontrol agents Companion™ (@16 fl oz in 100gal water) and Mycostop™ (@ 0.18 oz /1.3 gal of water) were made. Companion™ (single drench), was applied in the greenhouse at 4 weeks, just before transplanting to the field. Stem diameter above the cotyledons and internode length between first and second true leaf were measured at the time of transplanting using Spi stem gauge and a slender steel ruler respectively. Mechanical transplanting was done at 4 week stage on raised beds of 30ft x 5ft in twin rows with starter fertilizer. At 4 weeks

after transplant second drench of Companion™ (@ 32 oz / A) and Mycostop™ (@ 1-2g / 100 sq. ft.) was applied on the designated plots. At the same time total no. of fruits, flower clusters, and vegetative habit of the plants was recorded. Plots under chemical control were sprayed with Ridomil Gold™ / Bravo™ (@ 2lb / A). Sprays of Bravo 720 and Benlate™ (@1/2 lb / A) were made to the entire field for controlling the fungal diseases other than phytopthora. Fruits were harvested from the center 6ft of each bed at 10 weeks after transplant. Grading was done using marketable and cull categories using the USDA ripeness classification standard for fresh market tomatoes.

Results and Discussion

Significant differences in internode length and first cluster fruits due to paclobutrazol were recorded (Table 1). It was found that internode length was reduced by 32% and first cluster fruits increased by 68% in the paclobutrazol treated plants (Table 2). Also the number of second cluster flowers per plant was higher in paclobutrazol treated plants. It was observed that the plants treated with paclobutrazol were more compact and less viny. This shows that the affect of paclobutrazol, as seen on reproductive maturity and plant habit, starts depleting after 4-5 weeks in field. The difference in fruit yield was not significant (data not shown). Buckeye rot disease pressure in 2001 was low (Table 3). The fruit weight shows that Mycostop™ was least effective in control of the disease (Table 4). Summer 2002 studies should prove valuable in further analysis of the treatments.

Literature cited:

1) Latimer, J.G. 1992. Drought, paclobutrazol, abscisic acid and gibberlic acid as alternatives to daminozide in tomato transplant production. Journal of American Society of Horticulture Science 117(2): 243-247.
2) McKee, J.M.T. 1981. Physiological aspects of transplanting vegetables and other crops. II Methods used to improve transplant establishment. In Latimer, J.G. 1992. Drought, paclobutrazol, abscisic acid and gibberelic acid as alternatives to daminozide in tomato transplant production. Journal of American Society of Horticulture Science 117(2): 243-247.
3) Nishizawa, T. 1993.Growth and yield during the first year growing period as affected by paclobutrazol on greenhouse strawberry production. Acta Horticulture, Plant Growth Regulator, 329.
4) Pasian, C. and D.K. Struve. 2000. Paclobutrazol / Paintmix on the inside surface of plug cells to control plug height. ohioline.agohio_state-edu, Bulletin extension research.
5) Setia, R.C., G. Bathal and N. Setia. 1995. Influence of paclobutrazol on growth and yield of Brassica carinata A.Br. Plant Growth Regulation 16:121-127.
6) Souza-Machado,V., R. Pitblado, A. Ali and P. May. 1999. Paclobutrazol in tomato (*Lycopersicon esculentum*) for improved tolerance to early transplanting and earlier harvest maturity. Part1.Proceedings 6th International ISHS Symposium on the Processing Tomato. Acta Horticulture. 487, ISHS.

Table 1. Mean squares and significance. ** Highly significant difference at alpha 0.05

Source	df	Internode length		Flower/plant (4 wk after transplant)		Fruit/plant (4 wk after transplant)		Buckeye rot (wt)	
		Mean square	p value	Mean square	p value	Mean square	p value	Mean square	p value
Paclobutrazol	1	10.211**	<0.0001	0.154	0.097	4.585**	<0.0001	0.001	0.802
Disease control treatment	4	0.629	0.220	0.026	0.730	0.118	0.445	0.066**	0.029
Interaction	4	0.970	0.077	0.020	0.817	0.181	0.236	0.042	0.123
CV		26.61		22.59		26.39		68.56	

Table 2. Means for the Paclobutrazol treatment.

	No paclo*	**Paclo***
Internode length (cm)	2.9	1.9
Number of fruits/plant	1.0	1.7
Number of flowers/plant	0.9	1.1

* Paclobutrazol

Table 3. Means for Buckeye rot fruit weight. (Kg/ 6ft of bed).

Treatment	**No paclo**		**Paclo**	
	Mean	Std. Dev	Mean	Std. Dev
Control	0.153	0.253	0.138	0.115
Ridomil	0.338	0.312	0.196	0.296
Companion (double drench)	0.169	0.062	0.127	0.150
Companion (single drench)	0.147	0.207	0.154	0.308
Mycostop	0.221	0.254	0.471	0.268
$LSD_{0.05}$	0.15		0.15	

Table 4. Mean comparison of disease control treatments for Buckeye rot fruit weight (kg/ 6ft bed). Means with same letters are not significantly different at alpha level 0.05.

Treatment	**Mean**
Control	0.15^{b}
Ridomil	0.27^{ba}
Companion (double drench)	0.15^{b}
Companion (single drench)	0.15^{b}
Mycostop	0.35^{a}

Fruit Development Effects on the Speed of Germination and Vigor

of Normal and Dark Green Tomato (*Lycopersicon esculentum* Mill.) Seeds

G. Ramirez-Rosales, M. Bennett, M. McDonald and D. Francis
Department of Horticulture and Crop Science
The Ohio State University

INTRODUCTION

Tomato fruit is an important source of antioxidants such as lycopene, which helps to reduce cancer diseases and heart attacks. Because of their physiological qualities as free radical scavengers, tomato breeders are now developing materials with high lycopene content. However, no varieties with super-elevated levels of lycopene are presently commercially available. One reason is that increasing lycopene levels using traditional and molecular biology approaches might alter metabolic pathways and cause abnormalities in other important physiological processes. For example, delayed germination and reduced plant growth have been reported in tomato mutants carrying the *hp* and *dg* genes, in which lycopene content is much higher (2-3X) compared to normal tomato genotypes (Jarret et al., 1984; Bewley and Berry, 1991; Berry and Uddin, 1991). Although evidence exists that high levels of carotenoids might modify the synthesis of essential germination promoters such as gibberellins (Fray et al., 1995), the cause or causes of low speed of germination in *hp* and *dg* tomato genotypes is not entirely clear. In addition, more research is needed to determine whether there is a direct effect of tomato fruit development and maturation on concomitant lycopene synthesis and expression of seed germination and longevity in tomato. Thus, if the synthesis of lycopene increases as the fruit matures (Arias et al., 2000) elevated levels of lycopene may be responsible for the reduced speed of germination of the *dg* and *hp* mutants. As a result, it might be possible to harvest in the early stages of fruit maturation, resulting in enhanced seed germination. Nevertheless, studies to test this hypothesis have not been conducted.

Objective

The objective of this research is to determine whether harvesting during the early stages of fruit development improves the speed of germination and seed vigor of a dark green genotype.

Materials and Methods

In spring 2001, two genotypes Flora-Dade and dgT4099 (wild type and high lycopene mutant respectively) were planted in the greenhouse. Seeds were planted in small trays, and seedlings were later transplanted to pots filled with Metro-mix 360^{TM}. Plants were cultivated at temperatures fluctuating around 25°C during the growing season. Fruits were harvested at five maturation stages: mature green, breaker, pink breaker, red mature and over-ripe following the criteria described by Valdes and Gray (1998). Seeds were extracted by hand, and fermented in plastic bags, which were sealed and stored in a closed container. The fermentation process was conducted for 48h at room

temperature (~24 ^{0}C). Seeds were rinsed and surface dried at room temperature to an approximate seed moisture content of 8 % (dry weight basis).

Seed quality was evaluated by the standard germination test, which was conducted on dry seeds and fresh seeds (seeds extracted after the fermentation process without any desiccation). Four replications were sown in Petri dishes with double layers of blotter paper filled with 10 ml dd water. Petri dishes were placed in a germination chamber at 25 C° and a 16/8 h light and dark cycle. Percentage of seeds with visible germination (radicle protrusion) and percentage of normal seedlings were determined after 5d and 14d. Seedlings were considered normal when the radicle and the shoot had more than 2.0 cm and 1.5 cm of growth respectively.

Differences between genotypes were statistically evaluated at each stage of fruit maturation using the analysis of repeated measures. Differences among maturities within genotypes was evaluated using a complete randomized design with two reps. Treatment means were compared using LSD at α=0.05. Data were transformed using arcsine square root although the original values are shown.

Results and discussion

Germination percentage of fresh seeds at 5 d (normal seedlings) in Flora-Dade increased from mature green to red mature and remained constant from red mature to over-ripe fruits (Figure 1A). Germination was greater than 90 % in red mature and over-ripe maturity stages. In dgT4099, germination increased from mature green to pink breaker; however, germination was never greater than 25 % (Figure 1A; Table 1). Germination percentage of dry seeds followed the same pattern as that of fresh seeds. However, percentages were lower for dry seeds than were for fresh seeds (Figure 1B). The germination of Flora-Dade was not greater than 80 % and that of dgT4099 was not greater than 25 %. Flora-Dade showed a higher germination than dgT4099 at all fruit maturities ($p<0.05$). This difference on germination at 5 d between Flora-Dade and dgT4099 is consistent with the low speed of germination reported for genotypes carrying the dg gene.

At 5d, Flora-Dade had a higher germination (radicle protrusion) of fresh seeds than dgT4099 at the Over-ripe stage. However, Flora-Dade showed a higher germination (normal seedlings) than dgT4099 at all fruit maturities ($p < .05$) (Table 1). For dry seeds, Flora-Dade showed a higher germination (radicle protrusion) than dgT4099 in all fruit maturities except the over-ripe stage ($p<0.05$) (Table 2). However for normal seedlings, Flora-Dade had a higher germination at all fruit maturities except mature green.

At 14d, dgT4099 showed a higher germination (radicle protrusion) of fresh seeds than Flora-Dade at the mature green stage. ($p<0.05$) (Table 3). However, Flora-Dade showed a higher germination (normal seedlings) than dgT4099 at the pink breaker stage (table 4) ($p< 0.05$). The more consistent difference between Flora-Dade and dgT4099 was observed at 5d for normal seedlings.

No significant differences between maturities within Flora-Dade were observed for germination at 5d and 14d (radicle protrusion) and 14d (normal seedlings) ($p<0.05$) (Table 5). However, 5d

germination (normal seedlings) of seeds from red mature and over-ripe fruit had a higher percentage, while mature green showed the lowest value (Table 5).
Within dgT4099, there was no significant difference between maturities for germination at 14d (normal seedlings). However, for radicle protrusion at 5d and 14d, seeds from the over-ripe fruit had a lower germination compared to the rest of fruit maturities (Table 5). Fort 5d normal seedlings, seeds from mature green and breaker fruit had a lower value (Table 5)

The comparison between maturities within genotypes of dry seeds showed no significant difference between maturities within Flora-Dade for germination at 14 d (radicle protrusion). However, for normal seedlings, mature green and over-ripe showed the lowest germination (Table 6). At 5d the mature green had the lowest germination for both radicle protrusion and normal seedlings. Within dgT4099, there was no difference at 14d for radicle protrusion and normal seedlings although at 5d pink breaker and over-ripe had the highest germination (Table 6)

Germination percentage at 5 d (normal seedlings) of Flora-Dade followed similar pattern for fresh and dry seeds (Figure 1 A, B). However, germination percentage was lower in most fruit maturities in dry seeds compared to fresh seeds. The germination of dgT4099 shows similar pattern for fresh and dry seeds as well, but the difference between fresh and dry seeds is less marked compared to Flora-Dade (figure 1A, 1B). This suggests that there is difference between these two genotypes for desiccation tolerance, with Flora-Dade more affected by this process.

Germination percentage at 5 d showed that Flora-Dade had a high percentage of fresh seeds with radicle protrusion (› 90 %) in all fruit maturities (Table 1). In contrast, dgT4099 had lesser percentage of seeds with radicle protrusion for mature green, pink breaker and over-ripe fruit maturities. Nevertheless, the difference between Flora-Dade and dgT4099 was less marked for percentage of seeds with radicle protrusion compared to percentage of normal seedlings. Thus, it appears that the differences between these two genotypes is more seedling development than biological germination (radicle protrusion). However, Flora-Dade initiated the germination process earlier than dgT4099, and by the fifth day, some seeds already become normal seedlings. Genotype dgT4099, in contrast, initiated the germination process later, so by the fifth day seedlings were not developed enough to be considered as normal. However, they continued developing and eventually became normal seedlings. This finding is important because the rules for seed testing indicate that tomato seeds should be evaluated at 5 and 14 days after planting (ISTA, 1999). The five-day count is usually used as an indicator of seed vigor. If genotypes carrying the dg gene showed low germination percentage at 5 d, they will be recorded as low vigor seed, when in effect those genotypes have different germination behavior.

Flora-Dade had a lower germination percentage (radicle protrusion) in the mature green stage for dry seeds compared to that of fresh seeds (Figure 1). A similar trend was observed for the over-ripe stage. On the other hand, genotype dgT4099 had a lower germination percentage for the mature green and breaker stage for dry seeds, as also seen seeds in fresh seeds.

Germination 14 d was similar for Flora-Dade and dgT4099 for fresh seeds (Table 1). However, dgT4099 showed lower germination percentage at the over-ripe fruit maturity for radicle protrusion and normal seedlings (~85 %) while Flora-Dade had lower germination percentage (normal seedlings) at the mature green stage. For dry seeds, the germination of dgT4099 was similar to that of Flora-Dade across fruit maturities. The germination (normal seedlings) of mature green and over-ripe fruits was greater for dry seeds compared to fresh seeds.

Desiccation is a mechanism beneficial to orthodox seeds. This process enables seeds to be stored for long periods and to acquire acceptable germination percentage even though the speed of germination is reduced. In this study, the mature green stage was in general more affected by desiccation compared to the rest of fruit maturation stages. This observation suggests that seeds have not accumulated adequate levels of protective compound(s) to tolerate desiccation. However, in the pink breaker and red mature stages, seeds are mature enough to be desiccated and stored until next season without decreasing seed germination. Seeds from over-ripe fruits have lower quality (Valdes and Gary, 1998). In this study the effect of over-ripe fruits on seed quality was not consistent. This inconsistency may be due to that fruits were classified as over-ripe based on their firmness. Fruits may change from firm to soft without immediate effect on seed quality. However, as fruit continues to ripen, seeds may advance in the deterioration process, although the sort and cause of seed deterioration associated with over-ripe fruits is not entirely clear. It is possible that the water potential of the juice surrounding the seed increases allowing the early events of the germination to occur. Once seeds initiate germination they become more susceptible to desiccation which results in lower seed quality.

Beneficial effects of the enhanced lycopene genotypes on human health and nutrition make the dg genotype desirable for commercial cultivars. However, the deleterious effects associated with this gene may impede its use. This study evaluated whether harvesting in early fruit maturation stages could improve the speed of germination of dgT4099. Results suggest that the effect of dg gene on the speed of germination is independent of the accumulation of lycopene. That is, even when fruits at early maturation stages such as mature green and breaker have low lycopene content, the speed of germination is similar to that of late maturation stages. Although the cause of low speed of germination of dgT4099 remains obscure, the study of high pigment genotypes including those carrying the dg gene will be beneficial for understanding the possible role of lycopene and other carotenoids in seed germination physiology.

References

Arias, R., Lee, T., Logendra, L., and Janes, H. (2000). Correlation of lycopene measured by HPLC with the L*,a*,b* color readings of hydroponic tomato and the relationship of maturity with color and lycopene content. *J. Food Agricultural Science*

Berry, T., and Bewley, D. J. (1991). Seeds of tomato (*Lycopersicon esculentum* Mill.) which develop in a fully hydrated environment in the fruit switch from a developmental to a germinative mode without a requirement for desiccation. *Planta* **186**, 27-34.

Berry, S.Z. and Uddin M.R. (1991). Breeding tomato for quality and processing attributes. In: Genetic Improvement of Tomato. (ed.) Kaloo. pp. 197-206. Springer-Verlag, Berlin.

Fray, R.G., Wallace, A, Fraser, P.D., Valero, D, Hedden. P. Bramley P.M. and Greierson D. (1995). Constitutive expression of a fruit phytoene synthase gene in transgenic tomatoes causes dwarfism by redirecting metabolites from the gibberellin pathway. *Plant Journal* **8**: 693-701.

International Seed Testing Association (1999). *Seed Science and Technology **27**,* supplement

Jarret, R.L., Sayana, H. and Tigchelaar , E. C. 1984. Pleotropic effects associated with the chlorophyll intensifier mutants *high pigment* and *dark green* in tomato. *J. Amer. Soc. Hort. Sci.* **109**, 873-878.

Valdes, V. M. and Gray, D. (1998). The influence of stage of fruit maturation on seed quality in tomato (*Lycopersicon lycopersicum* L.) *Seed Science and Technology* **26**, 309-318.

Acknowledgment

We want to thank the *Ohio Agricultural Research and Development Center Research Enhancement Competitive Grant Program (OARDC- RECG)* for partial funding of this research. We also want to thank the *National Council for Science and Technology of Mexico (CONACyT)* for financial support of Gerardo Ramirez-Rosales' doctoral program.

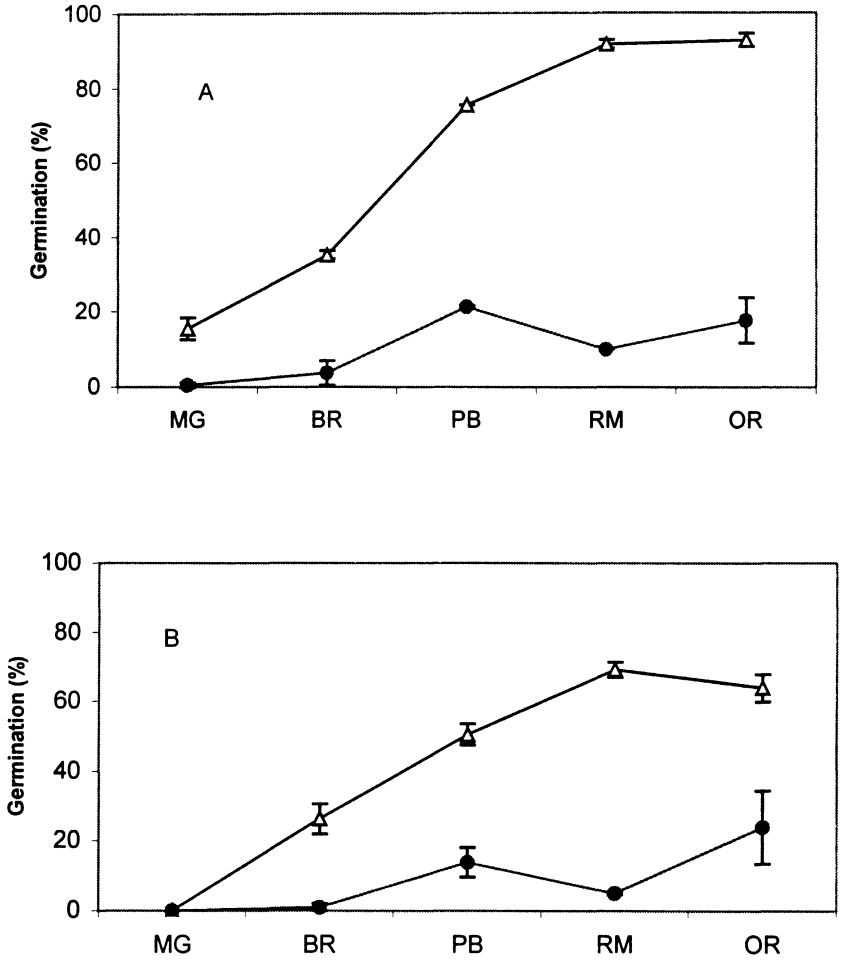

Figure 1. Germination percentage at 5 d (normal seedlings) of two tomato genotypes; dgT4099 (•) and Flora-Dade (Δ) harvested at five fruit maturity stages: mature green (MG), breaker (BR), pink breaker (PB), red mature (RM), and over-ripe (OR) in summer 2001. Fresh seeds (A) Dry seeds (B)

Table 1. Mean comparison for germination of fresh seeds at 5d of two genotypes (Flora-Dade, dgT4099) harvested at five maturities (mature green, breaker, pink breaker, red mature and over-ripe). Summer 2001.

	MG		BR		PB		RM		OR	
	rad	nor	rad	nor	rad	Nor	rad	nor	rad	Nor
Flora-Dade	92.7 a	15.5 a	98.0 a	35.5 a	90.5 a	75.5 a	93.0 a	91.7 a	95.0 a	92.7 a
dgT4099	73.2 a	0.0 b	93.0 a	3.75 b	76.0 a	21.2 b	97.0 a	10.0 b	59.0 b	17.7 b

Values with the same letter are not significantly different at α 0.05

Table 2. Mean comparison for germination of dry seeds at 5d of two genotypes (Flora-Dade, dgT4099) harvested at five maturities (mature green, breaker, pink breaker, red mature and over-ripe). Summer 2001.

	MG		BR		PB		RM		OR	
	rad	nor	rad	nor	rad	Nor	rad	nor	rad	Nor
Flora-Dade	85.5 a	0.0 a	99.5 a	26.5 a	98.7 a	50.5 a	97.5 a	69.2 a	92.6 a	64.0 a
dgT4099	55.2 b	0.0 a	61.2 b	1.0 b	83.0 b	13.7 b	83.0 b	4.9 b	85.3 a	24.0 b

Values with the same letter are not significantly different at α 0.05

Table 3. Mean comparison for germination of fresh seeds at 14 d of two genotypes (Flora-Dade, dgT4099) harvested at five maturities (mature green, breaker, pink breaker, red mature and over-ripe). Summer 2001.

	MG		BR		PB		RM		OR	
	rad	nor	rad	nor	rad	nor	rad	nor	rad	Nor
Flora-Dade	97.3 a	83.3 b	94.5 a	99.5 a	99.8 a	94.5 a	99.3 a	99.5 a	98.0 a	95.3 a
dgT4099	99.0 a	99.0 a	98.5 a	98.5 a	98.0 a	97.6 a	97.3 a	97.3 a	84.5 a	84.5 a

Values with the same letter are not significantly different at α 0.05

Table 4. Mean comparison for germination of dry seeds at 14 d of two genotypes (Flora-Dade, dgT4099) harvested at five maturities (mature green, breaker, pink breaker, red mature and over-ripe). Summer 2001.

	MG		BR		PB		RM		OR	
	rad	nor	rad	nor	rad	nor	rad	nor	rad	Nor
Flora-Dade	97.5 a	95.0 a	100 a	100 a	98.7 a	98.2 a	96.7 a	96.7 a	94.0 a	87.1 a
dgT4099	99.2 a	98.0 a	92.0 a	92.0 a	94.3 a	83.0 b	98.0 a	98.0 b	97.0 a	97.0 a

Values with the same letter are not significantly different at α 0.05

Table 5. Germination percentage of two tomato genotypes (Flora-Dade, dgT4099) harvested at five fruit maturities: Mature green (MG), Breaker (BR), Pink Breaker (PB), Red mature (RM), and over-ripe (OR). Fresh seeds

		Radicle		Normal	
		5d	14d	5d	14d
Flora-Dade	MG	92.7 a	97.3 a	15.5 d	83.3 a
	BR	98.0 a	99.5 a	35.5 c	99.5 a
	PB	90.5 a	99.8 a	75.5 b	94.5 a
	RM	93.0 a	99.5 a	91.7 a	99.5 a
	OR	95.0 a	98.0 a	92.7 a	95.3 a
dgT4099	MG	73.2 bc	99.0 a	0.0 c	99.0 a
	BR	93.0 ab	98.5 a	3.75 bc	98.5 a
	PB	76.0 bc	98.0 a	21.2 a	97.6 a
	RM	97.0 a	97.3 a	10.0 ab	97.3 a
	OR	59.0 c	84.5 b	17.7 a	84.5 a

Values with the same letter are not significantly different at α 0.05

Table 6. Germination percentage of two tomato genotypes (Flora-Dade, dgT4099) harvested at five fruit maturities: Mature green (MG), Breaker (BR), Pink Breaker (PB), Red mature (RM), and over-ripe (OR). Dry seeds

		Radicle		Normal	
		5d	14d	5d	14d
Flora-Dade	MG	85.5 c	97.5 a	0.0 d	95.0 bc
	BR	99.5 a	100 a	26.5 c	100.0 a
	PB	98.7 ab	98.7 a	50.5 b	98.2 ab
	RM	97.5 ba	96.7 a	69.2 a	96.7 abc
	OR	92.6 bc	94.0 a	64.0 a	87.1 bc
dgT4099	MG	55.2 b	99.2 a	0.0 c	98.0 a
	BR	61.2 b	92.0 a	1.0 bc	92.0 a
	PB	83.0 a	94.3 a	13.7 a	83.0 a
	RM	83.0 a	98.0 a	4.9 b	98.0 a
	OR	85.3 a	97.0 a	24.0 a	97.0 a

Values with the same letter are not significantly different at α 0.05
Note: mean comparison was conducted between maturities within genotypes.

Sweet Corn Seed Treatment and Seedling Establishment Trial – 2001

Mark Bennett, Elaine Grassbaugh and Matt Hofelich
OSU/OARDC
Dept of Horticulture and Crop Science
Ohio State University

Objective:

Thirteen seed treatments plus an untreated control were tested on two cultivars of sweet corn (*se* 'July Gold' and sh_2 'Even Sweeter') to determine the best seed treatments for optimum stand establishment.

Materials and Methods:

Plots were established at the Veg Crops Branch in Fremont, Ohio on May 3, 2001. Four replications of 100 seeds each were planted in single rows spaced 30" apart with 4-5" between seeds. Each cultivar was planted in a randomized block design. Soil type in Fremont was Hoytville silty clay loam. When plants reached at least the 5-6 leaf stage final stand counts were taken (June 28, 2001) to determine effective seed treatments for optimum stand establishment.

Results and Discussion:

Seedling emergence of untreated 'Even Sweeter' and 'July Gold' seeds was substantially lower (32%) than for seeds treated with any of the 13 seed treatments. The range of emergence for treated 'July Gold' (se) seeds ranged from 55-72%, with few significant differences (0.05 level) among the seed treatments. Emergence ranged from 59-82% for treated 'Even Sweeter' (sh2) seeds. Lower emergence was observed from treatments 1, 5, 6, and 11 (Table 1).

This project was part of a multi-location trial organized by the Seed Treatment Committee of the National Sweet Corn Breeders Association, a non-profit research organization. The information generated from this national study will be of value to sweet corn producers, industry personnel, consultants, farm advisers, extension plant pathologists and others interested in identifying the best performing seed treatments for optimum stand establishment.

Acknowledgements:

We would like to thank the *Ohio Vegetable and Small Fruit Research and Development Program* for their financial support of this research.

Table 1. Sweet Corn Seed Treatment and Seedling Establishment Trial - 2001
Veg Crops Branch, Fremont, OH

Treatment number	Seed Treatment (oz/cwt)	----------% final stand---------- 'July Gold' (se)	'Even Sweeter' (sh2)
1	Captan 400 (3.0) + Thiram 42S (2.5) + Allegiance FL (0.75)	60	59
2	Captan 400 (3.0) + Thiram 42S (2.5) + Allegiance FL (0.75) + Flo-Pro IMZ (0.5)	69	73
3	Captan 400 (3.0) + Thiram 42S (2.5) + Allegiance FL (0.75) + Flo-Pro IMZ (0.5) + Gaucho 480 (4.0)	66	74
4	Captan 400 (3.0) + Thiram 42S (2.5) + Allegiance FL (0.75) + Flo-Pro IMZ (0.5) + Gaucho 480 (8.0)	63	73
5	Captan 400 (3.0) + Allegiance (0.75) + L0258 (2.5 g ai/100 kg)	69	57
6	Captan 400 (3.0) + Allegiance (0.75) + L0258 (5.0 g ai/100 kg)	72	61
7	Allegiance (0.75) + L0259 (2.5 g ai/100 kg) + L0258 (5.0 g ai/100 kg)	71	70
8	Maxim 4FS (0.08) + Apron XL (0.32) + Divident 3FS (0.5)	63	78
9	Maxim 4FS (0.08) + Apron XL (0.32) + Adage 5FS (1.28)	67	77
10	Maxim 4FS (0.08) + Apron XL (0.32) + Adage 5FS (5.12)	65	77
11	Captan 400 (3.0) + Thiram 42S (2.5) + Allegiance FL (0.75) + PolySB (8.0)	55	62
12	Maxim 4FS (0.08) + Apron XL (0.32) + CGA 301940 (0.15)	72	82
13	Maxim 4FS (0.08) + Apron XL (0.32) + CGA 301940 (0.15) + Adage 5FS (1.28)	68	70
14	Untreated Check	32	32
LSD (0.05)		15.7	10.8
CV		21.8	20.9

Saturated Salt Accelerated Aging (SSAA) Test for Assessing and Comparing sh2 and se Sweet Corn Seedlots

Mark A. Bennett, Elaine M. Grassbaugh, and Andrew F. Evans
The Ohio State University
Department of Horticulture and Crop Science
Columbus, OH 43210

Introduction:

The accelerated aging test is a common and important seed vigor indicator for many large-seeded crops, but its utility for sweet corn (Zea mays L.) evaluation may be limited because of the anatomical and compositional differences among su, sh2 and se genotypes. The recent use of saturated salts in accelerated aging tests to reduce water uptake, microflora growth, and slow seed deterioration (Jianhua and McDonald, 1996) may also be useful in more accurately testing sweet corn genotypes.

A key component of quality assurance in the seed industry is seed vigor testing. Popular seed vigor tests include various accelerated aging and cold test methods, but their usefulness for high sugar sweet corn cultivars and inbreds is marginal (Bennett et al., 1988). Pericarp damage and pathogen levels in (or on) sh2 seed are especially troublesome (Borowski et al., 1991; Parera et al., 1996). Use of a saturated salt accelerated aging (SSAA) test is hypothesized to more accurately evaluate sweet corn seeds. The SSAA test should (1) reduce water uptake, (2) minimize microflora growth, and (3) slow overall seed deterioration, thereby allowing a more precise and repeatable measurement of sweet corn seed vigor. Results with the SSAA test have been promising with a small-seeded species and we believe the test has broader applications (Jianhua and McDonald, 1996).

The current guidelines used for field corn are too severe for sweet corn seed tests. The cold test is difficult, if not impossible to standardize because of the use of soil. The SSAA test should be easy to do, repeatable, and reliable. The results of this study could be used to develop guidelines for such a sweet corn vigor test. The objectives of this study were to test several sh2 and se genotypes using the SSAA test and determine how closely it correlates to the standard germination test, standard accelerated aging (AA) and cold test results.

Materials and Methods:

Lab studies in 2001 examined 12 sh2 and 6 se sweet corn cultivars, plus one field corn variety (Table 1). An inner tray accelerating aging apparatus was used. The seeds were placed on a wire mesh in a single layer with the solutions [water (AA) or NaCl (SSAA)] beneath them. Seeds were aged for 72 hours at various test temperatures (41, 43 or 45°C). Seeds were then evaluated for percentage of normal, abnormal and dead seedlings after 7 days at 25°C. Seed moisture content (dry weight basis) was also measured before and after the AA and SSAA aging to measure water uptake when seeds

are exposed to water only (near 100% R.H.) or salt solution (76% R.H.) environments at the various temperatures (Table 2).

Results and Discussion:

Standard germination results show percent normal seedlings above 80% for all cultivars and genotypes. SSAA and AA results for 41°C resulted in normal seedlings above 75% for all but one cultivar. When exposed to temperatures of 43 and 45°C, percent abnormal and dead seedlings increased when seeds were aged under higher temperatures. With most cultivars, percent normal seedlings were generally higher from SSAA compared to AA tests (Table 1).

Percent kernel moisture was higher for all cultivars at all temperatures when seeds are suspended above water only compared with NaCl solution in the SSAA test (Table 2).

Table 1. Standard germination, saturated salt accelerated aging (SSAA) and accelerated aging (AA) for sh2, se and Su (Zea mays L.) seedlots - 2001.

Sh2 Cultivars	Seed Source	Percent Field Emergence	Standard germination			41C					
						SSAA			AA		
			N*	A*	D*	N	A	D	N	A	D
8102R	AC	94.7	98	1	1	98	1	1	97	2	1
ACX 946	AC	84.3	85	9	6	76	6	18	80	4	16
BSS 0977 VP Attribute	Syngenta	89.0	94	4	2	85	7	8	80	14	6
Candy Corner	HM	99.9	97	2	1	99	0	1	96	3	1
GS 277A	ST	82.7	90	4	6	84	10	6	88	6	6
PS 8201	PS	97.7	94	5	1	96	4	0	89	6	5
ACX 945 (ID - lot 70532)	AC	NA	95	2	3	97	1	2	90	4	6
ACX 945 (Idaho)	AC	NA	94	4	2	97	3	0	94	3	3
ACX 945 (Chile - lot 70951P	AC	NA	93	4	4	94	2	4	89	4	7
ACX 945 (Chile - 70951P-KB)	AC	NA	92	4	4	96	2	2	93	2	5
ACX 817 (Chile - lot 70953)	AC	NA	84	8	8	76	8	16	72	10	18
ACX 817 (Chile 70953Q-KB)	AC	NA	87	10	3	90	5	5	46	14	40
DeKalb #DK595 (field)	DeKalb	NA	100	0	0	98	0	2	100	0	0
Se Cultivars											
Ambrosia	CR	81.3	96	4	0	92	6	2	94	4	2
Bojangles	CR	72.7	98	2	0	98	1	1	98	1	1
Ecstase II	SW	93.0	93	3	4	95	3	2	98	1	1
Precious Gem	SG	87.0	88	4	8	88	6	6	90	4	6
Sweet Rhythm	HM	96.3	94	1	5	92	3	5	96	1	3
Temptation	RI	100	98	1	1	97	2	1	91	4	5
LSD (0.05)			4.9	4.1	3.8	4.5	3.0	3.6	6.0	3.6	4.5
CV			5.9	93.8	11.0	8.3	89.8	12.3	14.4	10.3	13.2

* = N= normal seedlings; A = abnormal seedlings; D = dead seedlings

Table 1 (continued)

		43C						45C					
	Seed	SSAA			AA			SSAA			AA		
	Source	N	A	D	N	A	D	N	A	D	N	A	D
Sh2 Cultivars													
8102R	AC	96	2	2	92	4	4	95	3	2	88	4	8
ACX 946	AC	74	6	20	75	6	19	64	8	28	55	11	34
BSS 0977 VP	Syngenta	76	10	14	74	16	10	40	14	46	60	19	21
Candy Corner	HM	93	6	1	95	2	3	89	5	6	69	11	20
GS 277A	ST	72	10	18	84	6	10	55	20	25	70	10	20
PS 8201	PS	93	3	4	90	4	6	92	0	8	67	10	23
ACX 945 (ID - lot 70532)	AC	88	7	5	86	7	7	92	4	4	33	22	45
ACX 945 (Idaho)	AC	92	4	4	96	2	3	95	3	2	90	4	6
ACX 945 (Chile - lot 70951P	AC	94	2	4	86	3	11	89	2	9	72	10	18
ACX 945 (Chile - 70951P-KB)	AC	91	2	7	77	11	12	85	5	10	57	13	30
ACX 817 (Chile - lot 70953)	AC	30	27	43	35	18	47	54	22	24	31	19	50
ACX 817 (Chile 70953Q-KB)	AC	18	32	50	23	25	52	62	20	18	22	24	54
DeKalb #DK595 (field)	DeKalb	98	0	2	98	0	2	96	0	4	89	5	6
Se Cultivars													
Ambrosia	CR	88	6	6	84	10	6	85	10	5	66	22	12
Bojangles	CR	98	0	2	95	3	2	100	0	0	82	8	10
Ecstase II	SW	92	4	4	92	4	4	91	4	5	91	4	5
Precious Gem	SG	83	2	15	88	1	11	77	5	18	83	3	14
Sweet Rhythm	HM	92	2	6	91	2	7	87	6	8	75	7	18
Temptation	RI	92	4	4	93	3	4	94	3	3	85	4	11
LSD (0.05)		5.8	4.0	5.4	6.5	3.7	5.3	8.3	4.1	7.0	9.5	6.9	8.9
CV		26.5	12.8	12.3	24.3	10.7	12.0	22.1	10.6	10.7	31.2	73.0	72.2

* = N= normal seedlings; A = abnormal seedlings; D = dead seedlings

Table 2. Kernel moisture on dry weight basis for Su, sh2 and se (Zea mays L.) seedlots for SSAA and AA at various temperatures - 2001.

	- - - - - - - - - - - - - - - % kernel moisture (dry weight basis)- - - - - - - - - - - - - - -					
	41C		43C		45C	
Sh2 Cultivars	**SSAA**	**AA**	**SSAA**	**AA**	**SSAA**	**AA**
8102R	22.3	38.4	21.1	33.3	12.4	33.7
ACX 946	23.4	38.1	18.0	32.9	17.8	32.8
BSS 0977 VP	23.3	39.9	18.1	34.1	22.9	32.6
Candy Corner	20.1	37.3	16.9	33.0	15.4	27.2
GS 277A	21.2	35.7	16.8	29.1	18.7	29.0
PS 8201	20.6	35.4	17.6	30.7	19.2	27.5
ACX 945 (ID - lot 70532)	15.9	30.6	19.5	30.1	16.9	32.1
ACX 945 (Idaho)	17.7	30.7	18.7	31.0	17.6	32.7
ACX 945 (Chile - lot 70951P	18.9	32.2	19.3	30.3	15.7	33.2
ACX 945 (Chile - 70951P-KB)	24.0	31.1	18.4	30.6	19.6	34.6
ACX 817 (Chile - lot 70953)	23.1	38.2	24.7	40.4	25.6	39.8
ACX 817 (Chile 70953Q-KB)	19.3	35.6	26.1	36.9	33.6	40.2
DeKalb #DK595 (field)	15.2	23.2	16.8	24.4	18.1	26.4
Se Cultivars						
Ambrosia	27.7	40.3	19.6	30.2	23.8	30.2
Bojangles	23.4	37.6	23.5	30.5	24.4	31.3
Ecstase II	23.6	34.3	20.6	29.2	21.3	31.0
Precious Gem	25.1	41.3	19.3	33.6	23.0	35.9
Sweet Rhythm	23.6	38.3	16.9	26.5	19.5	26.7
Temptation	25.0	38.7	23.4	31.8	19.6	34.3

Paclobutrazol-Soaked Seed for Transplant Height Control and Improved Crop Production in Processing Cabbage and Pepper

Dr. Mark A. Bennett, Elaine Grassbaugh, Andy Evans and Matt Hofelich
The Ohio State University/OARDC
Dept. of Horticulture and Crop Science
Columbus, OH 43210

Introduction and Objectives:

Stretching and legginess in processing pepper and cabbage transplants becomes a problem when field planting in the spring is delayed due to weather conditions. Thin, weak stems and increased internode length can also be caused by cloudy or warm weather during transplant production. Difficulties in mechanical transplanting and field survival are challenges that processing pepper and cabbage growers face with increased transplant heights. Preliminary work in 2000 at OSU on processing tomatoes showed a stockier, shorter transplant can be produced with the use of the growth regulator paclobutrazol (Bonzi™) as a seed soak prior to sowing. Bonzi™ acts by inhibiting gibberellin biosynthesis, which is involved in seedling elongation. Significant differences in transplant height due to Bonzi™ treatment were recorded 10, 14, 21, 28, 35 and 56 days after seeding (DAS) into plug trays. At field transplanting (56 DAS) plants showed a significant difference in internode length and stem diameter. Final yield results and analysis showed no significant differences in marketable yields between dry control, water soaks, and Bonzi™ seed soaked seeds (Appendix 1 - pg.3).

Preliminary greenhouse work in 2000 at OSU on processing cabbage showed that 4 weeks after seeding into plug trays, cultivars 'Cheers' and 'Benefit' had significantly shorter transplants with the seed soak treatments, although no significant differences were recorded in leaf number or dry weight (Appendix 2).

Specific objectives of our 2001 research were (1) to compare several concentrations of Bonzi™ used as a cabbage and pepper seed soak prior to sowing into plug trays, and (2) to determine any subsequent effects in the field on flowering and/or time to harvest, yield, and fruit/head characteristics.

Research Methods:

Cabbage:

Cabbage ('Benefit') seeds were soaked in paclobutrazol solutions at 0, 500 and 1000 ppm for 5 or 45 minutes. Percent germination and plant heights were recorded at 7, 14, and 21 DAS. Seven-week-old plants were transplanted to the field on May 30, 2001 in a randomized complete block design in 3 replications of each seed soak concentration. Plant height, leaf number stem length and dry weights were recorded at field transplanting. Plant heights and head diameter measurements were recorded one month after transplant. Standard production practices for the Midwest U.S. (disease/insect management, fertilizer rates, weed control, etc.)

were followed throughout the growing season.

Plots were harvested on August 13. Marketable head number and weight were recorded. Core length, polar and equatorial head measurements were also collected. Cull head number and weight were also recorded.

Peppers:

Jalapeno pepper ('Mitla') seeds were soaked at the same concentrations for 5 or 45 minutes. Dry seed and water-soaked control treatments for both species were also tested. Seeds were dried back for at least 16 hours at 25°C before sowing into 288 plug trays. 'Mitla' transplants were seeded into 288 plug trays on April 16, 2001. Percent germination and plant height were recorded 2, 3, and 5 weeks after seeding. Plants were mechanically transplanted to the field on June 11 in single rows of 4 replications. Plant height, internode length and stem diameter were recorded at the time of field establishment. One month after transplanting to the field plant height, internode length and stem diameter measurements were recorded.

Fruits were harvested on August 13, September 7 and October 4. Marketable green and red T/A were recorded along with cull T/A.

Results and Discussion:

Cabbage:

Percent germination was lower (10-15%) for the 1000 ppm soaked seeds (Table 1). There were significant differences in plant heights in 'Benefit' transplants at 7, 14, and 21 DAS between the Bonzi™ soaked and unsoaked seeds. Differences in plant height due to Bonzi™ treatment were also present at the time of field establishment. One month after transplant, no significant differences were present in head diameter and plant height measurements which indicates that plants showed no long term adverse effects from the Bonzi™ seed soak. Yield results show a significant increase in yield with the Bonzi™ soaked seeds versus the dry control and water soak only treatments. Other head characteristics (average weight, core length, etc.) were not affected by seed treatment. Brief soaks (5 min.) of cabbage seed in 500 ppm Bonzi™ gave 13% reductions in seedling height at transplanting. Longer soaks (45 min.) in 500 ppm Bonzi™, or either of the 1000 ppm Bonzi™ treatments produced seedling height reductions of approximately 35% (Table 1).

Peppers:

Percent germination was significantly lower for the Bonzi™ soaked seeds compared to dry control and water soak only (Table 2). Rate effects (1000 ppm vs. 500 ppm) appear to be more damaging to germination than the soak times compared in 2001. At field establishment, seedling heights were reduced by 10-25% for plants from Bonzi™-treated seeds. Total yield

after 3 fruit harvests shows no significant differences in marketable green, total marketable (green + red) or cull fruit. Additional work in 2002 is needed to investigate reduced Bonzi™ concentrations to maximize pepper seed germination, while achieving desired reductions in transplant height.

Acknowledgments:

We would like to thank ***Pickle Packers International, Inc.*** and the ***Ohio Vegetable and Small Fruit Research and Development Program*** for their financial support of this project.

Appendix 2. Paclobutrazol Seed Soak for Height Control in Cabbage Transplant Production - 2000.

Cultivar: 'Benefit'

	7 DAS		14 DAS		21 DAS		28 DAS		
Seed Soak	**Germination (%)**	**Plant Ht. (cm)**	**Germination (%)**	**Plant Ht. (cm)**	**Germination (%)**	**Plant Ht. (cm)**	**Plant Ht. (cm)**	**Leaf Number**	**Dry wt. (g)**
Dry seed control	80	2.2	83	5.1	83	6.8	10.8	4.5	1.10
H2O - 5 min.	72	2.2	75	4.9	75	5.8	10.2	4.3	1.09
H2O - 45 min.	78	2.4	83	4.8	83	6.5	11.5	4.2	0.98
500 PPM - 5 min.	82	1.0	88	2.9	88	4.8	8.9	4.6	0.95
500 PPM - 45 min.	80	1.0	84	2.8	84	4.8	8.7	4.6	0.90
1000 PPM - 5 min.	78	0.8	84	2.4	84	4.5	8.6	4.7	0.91
1000 PPM - 45 min.	71	0.8	79	1.8	82	3.8	7.3	4.6	0.83
LSD (0.05)	NS	0.81	NS	1.99	NS	2.08	4.15	NS	NS
p value	0.62		0.428		0.516			0.334	0.335
CV	12.2	51.5	9.9	38.8	9.9	22.0	17.7	7.2	

Cultivar: 'Cheers'

	7 DAS		14 DAS		21 DAS		28 DAS		
Seed Soak	**Germination (%)**	**Plant Ht. (cm)**	**Germination (%)**	**Plant Ht. (cm)**	**Germination (%)**	**Plant Ht. (cm)**	**Plant Ht. (cm)**	**Leaf Number**	**Dry wt. (g)**
Dry seed control	95	2.2	95	5.1	96	8.8	10.2	3.6	0.96
H2O - 5 min.	92	1.8	95	4.6	95	8.3	10.8	3.6	1.00
H2O - 45 min.	94	2.2	95	5.1	95	8.2	10.8	3.6	1.14
500 PPM - 5 min.	89	0.8	90	2.7	90	6.2	8.7	3.7	0.95
500 PPM - 45 min.	84	0.7	90	2.7	90	6.4	8.5	3.6	0.81
1000 PPM - 5 min.	79	0.4	89	2.0	89	5.5	8.5	3.8	0.81
1000 PPM - 45 min.	82	0.5	87	2.1	89	5.1	8.4	3.9	0.84
LSD (0.05)	10.0	0.2	NS	0.61	NS	1.05	2.04	NS	NS
p value			0.476		0.361			0.635	0.338
CV	9.6	62.8	7.5	39.0	6.5	22.1	17.1	8.5	

Table 1. Bonzi Seed Soak for Cabbage Transplant Height Control and Crop Production Traits- 2001.
Veg Crops Branch, Fremont, OH.

Cultivar: 'Benefit'	7 DAS		14 DAS		21 DAS		At transplant				1 mth. after transplant		Yield					
Treatment	% germ	Plant ht (cm)	% germ	Plant ht (cm)	% germ	Plant ht (cm)	Plant ht (cm)	Leaf no.	Dry wt. (g)	Stem diam. (mm)	Head diam. (cm)	Plant ht. (cm)	Marketable T/A	Avg. head wt. (lbs)	Cull T/A	Polar (inches)	Equatorial (inches)	Core length (inches)
Dry Control	77.3	2.3	79.3	5.6	79.3	8.8	15.8	4.1	1.5	4.0	31.8	17.2	9.9	3.1	2.9	5.5	6.2	1.6
H2O - 5 mins.	78.0	2.9	75.3	6.3	75.3	9.6	15.1	5.1	1.7	4.0	33.4	17.0	13.9	3.0	2.8	5.5	5.7	1.9
H2O - 45 mins.	78.0	2.3	79.3	6.5	79.3	10.0	16.1	5.8	2.1	3.6	32.3	17.6	17.9	2.9	2.2	5.4	5.9	2.0
500 ppm - 5 mins.	73.3	1.0	73.3	4.0	73.3	7.4	13.6	4.3	1.0	2.3	31.7	16.2	21.9	3.3	4.3	5.6	6.0	1.7
500 ppm - 45 mins.	73.3	1.1	74.7	3.3	74.7	7.3	10.3	5.6	1.1	1.6	31.8	15.5	25.9	2.9	0.7	5.7	5.9	1.9
1000 ppm - 5 mins.	63.3	0.5	64.7	1.9	64.7	5.4	9.8	6.5	1.0	0.9	31.3	18.2	29.9	3.2	2.8	5.7	5.9	1.9
1000 ppm - 45 mins.	61.3	0.7	66.7	2.3	66.0	5.2	9.5	4.5	0.8	0.8	32.1	18.0	33.9	3.1	1.1	5.5	5.8	1.7
LSD (0.05)	9.52	0.37	8.51	0.49	8.37	0.66	1.03	0.63	0.18	0.39	NS	NS	1.75	NS	NS	NS	NS	NS
p value											0.951	0.404		0.687	0.19	0.971	0.772	0.901
CV	11.1	59.6	9.3	42	9.4	24.1	22	17.2	35.2	55.6	6.5	9.5	37.6	11.1	74.3	6.8	5.4	19.6

Table 2. Paclobutrazol Seed Soak for Jalapeno Pepper Transplant Height Control and Crop Production - 2001
Veg Crops Branch, Fremont, OH

Cultivar: 'Mitla'

	-----2 WAS*----		-------3 WAS--------		--------5 WAS -------		----AT TRANSPLANT----			ONE MONTH POST TRANSPLANT			----------YIELD**----------			
Seed Soak	% germ.	Plant ht (cm)	% germ.	Plant ht (cm)	% germ.	Plant ht (cm)	Plant ht (cm)	Internode length (cm)	Stem diam (mm)	Plant ht (cm)	Internode length (cm)	Stem diam (mm)	Marketable green T/A	Marketable red T/A	Total mktable. yield T/A	Cull T/A
Dry control	89.5	5.2	89.5	15.9	89.5	19.7	24.5	7.1	3.0	33.4	3.4	6.7	18.3	0.5	18.8	0.05
H2O - 5 mins.	90.5	5.8	90.5	17.4	90.5	22.3	23.8	7.0	3.2	33.9	3.7	6.5	18.0	1.2	19.2	0.08
H2O - 45 mins.	93.5	4.8	93.5	15.6	93.5	20.4	23.4	7.0	3.2	32.2	2.9	6.4	17.5	0.7	18.2	0.07
500 ppm - 5 mins.	65.5	2.3	67.0	11.1	67.0	17.3	18.4	5.3	2.4	30.3	2.4	6.6	16.9	0.9	17.8	0.03
500 ppm - 45 mins.	68.0	1.9	68.5	10.4	68.5	18.5	22.0	6.7	3.1	29.3	2.3	7.4	17.2	0.7	17.9	0.06
1000 ppm - 5 mins.	47.5	1.6	51.5	8.9	51.5	15.9	20.3	4.7	2.9	28.2	2.9	6.4	17.2	0.9	18.1	0.06
1000 ppm - 45 mins.	44.0	1.3	47.5	8.7	47.5	13.8	18.0	5.1	3.0	28.8	2.6	7.1	17.7	1.6	19.3	0.06
LSD (0.05)	11.51	0.29	9.93	0.64	9.93	1.34	1.28	0.59	0.26	2.99	0.92	NS	NS	0.64	NS	NS
p value												0.176	0.778		0.589	0.891
CV	29	56.3	26	27.4	26	15.4	12.1	17	10	9.1	25.8	9.1	7.1	56.2	7.5	87.3

* WAS = weeks after seeding

** = Harvest dates: August 13
September 7
October 4

Comparision of Three Priming Techniques for Onion Seed Lots Differing in Initial Seed Quality

R. Caseiro, M. Bennett and J. Marcos Filho

Introduction

Priming is a technique that can improve seed performance by reducing the time to germination and seedling emergence, and also by increasing the tolerance of seeds to stress conditions. Priming involves controlled seed hydration into the second stage of imbibition, where various metabolic process are activated, but without permitting radicle protrusion. Research to date has provided several priming procedures which can lead to different results. Another factor that can affect seed priming results is the initial quality of the seeds.

The objective of this study was to compare the effect of hydropriming (germination paper moistened with water), drum priming and osmopriming (aerated PEG 8000 solution) on germination speed and percentage using six lots of onion (*Allium cepa*) seeds, differing in initial seed quality.

Material and methods

Priming treatments

Six lots of onion seeds, cultivar Granex 33, were used. Samples of seeds from each lot were subjected to three kinds of priming treatment. In the drum priming technique, seeds were hydrated in four cycles, at 15°C and 25°C, with the optimal amount of water added and treatment duration varying among seed lots. In the hydropriming method, seeds were exposed to 2, 4 or 6 layers of moistened germination paper, for 2 or 4 d, at 15°C. For the osmopriming method, osmotic potentials of – 0,5 MPa and –1,0 MPa and imbibition periods of 1 and 2 d, at 15°C, were used.

Tests used to evaluate seed quality

a) Germination test: four replications of 50 seeds from each treatment were placed inside germinator box and kept at 20°C. Evaluation of normal seedlings was done daily, until final count made 12 d after planting (ISTA, 1999).

b) Speed of germination index: this evaluation was carried out together with germination test (according to Nakagawa, 1994). At the end of the test, with the daily data of normal seedlings, the index of speed of germination was calculated by the following formula:

$ISG = (G_1 \div N_1) + (G_2 \div N_2) + \ldots + (G_n \div N_n)$; where:

ISG = index of speed of germination

G_1, G_2, G_n = number of normal seedlings computed at the first counting, second counting and last counting.

N_1, N_2, N_n = number of the days after planting at the first, second and last counting.

c) Saturated salt accelerated aging (SSAA): this procedure was based on methodology proposed by Jianhua and McDonald (1996). Onion seeds were kept 41°C (± 0.3°C) and approximately 100% R.H. for 72h. After this period, seeds were tested using the same procedure described above in the germination test. The speed of germination index was also calculated.

d) Seed moisture content: was conducted using the oven method (105°C ± 3°C, for 24 h) with two replicates for each lot. The results were expressed on a fresh weight basis.

Experimental design and statistical analysis

Completely randomized design was used with four replications for each treatment. For statistical analysis, the data were transformed in arc sin $\sqrt{x}/100$ and the treatment means were compared by Tukey's test at P=0.05.

Results and discussion

Differences in initial seed quality of the six lots of onion seeds can be observed by the data shown in the table 1. In the present study, the response to priming methods varied among lots (table 2 for lots 1 and 5; table 3 for lots 2, 3 and 6 and table 4 for lot 4). For lot 1 (table 2), all priming treatments improved both percentage and speed of germination. On the other hand, lot 5 (table 2) that presented almost the same germination percentage and index of speed of germination as lot 1, but which had lower significantly values to SSAA and speed of germination on SSAA (table 1), did not response to any priming procedure.

The effects of priming treatments were also different for lots 2, 3 and 6 that were close in germination percentage and in the index of speed of germination results, but showed some differences in the SSAA and in the index of speed of germination in SSAA tests (table 1). There was no germination response to priming method for lot 2 (table 3). However, the speed of germination was increased by nearly all priming procedures. Both lot 3 and lot 6 (table 3), had the germination affected by priming. But lot 6, which was less vigorous than lot 3, presented higher decrease in germination percentage and also had its index of speed of germination affected by approximately all treatments.

Lot 4 (table 4), having only 41% germination, gave a negative germination and speed of germination response to priming. It has been reported that priming treatment is not effective to improve seed performance for low vigor seed lots (Heydecker and Coolbear, 1977; Dearman et al., 1986). However, the results about the effect of priming treatment in lots presenting different initial seed quality seem not be consistent for onion seeds, since some reports have also demonstrated that slow-germinating seed lots gave a greater response to priming (Brocklehurst and Dearman, 1983; Drew et al., 1997). The data in the present study showed, in general, that less vigorous onion seed lots did not respond well to priming treatments. Because of that lack of consistent results, in case of a commercial treatment, preliminary tests should be done in order to choose the seed lots that respond better to priming.

Table 1. Results of germination test (%), index of speed of germination, saturated salt accelerated aging (%), index of speed of germination on SSAA and moisture content, of six lots of hybrid onion seeds, cultivar Granex 33.

Lots	Parameters				
	Germination Test (%)	**Index of Speed of Germination**	**Saturated Salt Accelerated Aging (%)**	**Index of Speed of germination on SSAA***	**Moisture Content (%)**
1	78 b	5,46 b	18,0 a	1,28 a	7,9
2	87 a	7,39 a	11,0 bc	1,03 ab	9,1
3	91 a	8,13 a	17,0 ab	1,38 a	8,5
4	41 c	2,47 c	1,0 d	0,05 c	8,8
5	79 b	5,82 b	1,0 d	0,06 c	8,5
6	87 a	7,30 a	9,0 c	0,59 b	8,5
C.V	5,65	9,67	23,0	46,5	

* SSAA - Saturated Salt Accelerated Ageing.

Table 2. Germination percentage, speed of germination index and moisture content (%) of onion seeds, cultivar Granex 33, lots 1 and 5, subjected to several osmopriming, hydropriming and drum-primer methods.

Treatments	LOT 1			LOT 5		
	Germination (%)	Speed of Germination Index	Moist Cont. (%)	Germination (%)	Speed of Germination Index	Moist. Cont. (%)
Untreated Seeds	78	5,46	7,9	79,0	5,82	8,5
... osmopriming ...						
-0.5 MPa, 1 day	87	7,05	41,9	76,0	5,74	40,4
-0.5 MPa, 2 days	84	7,38	45,7	76,0	6,01	44,2
-1.0 MPa, 1day	87	6,70	38,9	76,0	5,48	38,0
-1.0 MPa, 2 days	84	7,58	43,7	81,0	5,75	42,0
... hydropriming ...						
2 layers / 2 days	88	9,50	45,4	75,0	6,07	44,3
2 layers / 4 days	88	10,48	48,0	79,0	7,75	46,6
4 layers / 2 days	84	9,33	45,7	76,0	6,69	43,3
4 layers / 4 days	86	10,35	49,1	77,0	7,58	46,7
6 layers / 2 days	86	8,96	45,6	75,0	6,18	44,7
6 layers / 4 days	87	11,27	49,2	71,0	6,95	46,8
... drum-primer ...						
15°C	82	9,53	46,8	69,0	5,48	43,5
25°C	84	7,76	48,2			
C.V.						

Table 3. Germination percentage, speed of germination index and moisture content (%) of onion seeds, cultivar Granex 33, lots 2, 3 and 6, subjected to several osmopriming, hydropriming and drum-primer methods.

Treatments	LOT 2			LOT 3			LOT 6		
	Germination (%)	Speed of Germination Index	Moist Cont. (%)	Germination (%)	Speed of Germination Index	Moist. Cont. (%)	Germination (%)	Speed of Germination Index	Moist. Cont. (%)
Untreated Seeds	87	7,39	9,1	91	8,13	8,5	87	7,30	8,5
... osmopriming ...									
-0.5 MPa, 1 day	86	7,50	40,5	84	8,40	41,6	74	6,23	40,1
-0.5 MPa, 2 days	88	8,11	44,2	88	9,03	46,4	78	6,69	43,7
-1.0 MPa, 1day	86	7,35	38,6	83	7,64	39,6	76	6,10	38,3
-1.0 MPa, 2 days	88	8,17	42,5	87	8,49	44,1	81	6,79	41,7
... hydropriming ...									
2 layers / 2 days	88	9,85	43,4	82	9,45	44,7	75	7,12	43,4
2 layers / 4 days	86	11,45	47,0	87	13,06	49,3	81	9,42	45,5
4 layers / 2 days	83	8,57	45,7	83	10,34	45,4	70	7,00	42,6
4 layers / 4 days	89	11,76	47,7	86	12,19	48,8	74	8,64	45,3
6 layers / 2 days	87	9,23	44,2	82	9,87	46,5	67	6,55	43,5
6 layers / 4 days	88	12,53	46,7	75	11,74	49,3	72	8,81	45,2
... drum-primer ...									
15°C	75	7,37	46,7	67	6,25	42,7	65	6,16	47,3
25°C	87	9,52	46,8			47,4			42,9
C.V.									

Table 4. Germination percentage, speed of germination index and moisture content (%) of onion seeds, cultivar Granex 33, lot 4, subjected to several osmopriming, hydropriming and drum-primer methods.

Treatment	LOT 4		
	Germination (%)	Speed of Germination Index	Moist. Cont. (%)
Untreated seeds	41,0	2,47	8,8
... osmopriming ...			
-0,5MPa, 1 day	31,0	1,84	39,3
-0,5MPa, 2 days	35,0	2,38	43,8
-1,0MPa, 1 day	26,0	1,51	37,2
-1,0MPa, 2 days	39,0	2,33	42,3
... hydropriming ...			
2 layers / 2 days	21,0	1,41	43,1
2 layers / 4 days	32,0	2,55	46,5
4 layers / 2 days	32,0	2,21	42,4
4 layers / 4 days	31,0	2,39	46,4
6 layers / 2 days	28,0	1,74	43,6
6 layers / 4 days	30,0	2,26	46,0
... drum-primer ...			
15°C			45,6
25°C			44,7
C.V.			

References

Brocklehurst, P.A. and Dearman, J. (1983). Interactions between seed priming treatments and nine seed lots of carrot, celery and onion. I. Laboratory germination. *Annals of Applied Biology*, **102**, 577-584.

Dearman, J., Brocklehurst, P.A. and Drew, L.K. (1986). Effects of osmotic priming and aging on onion seed germination. *Journal of Applied Biology*, **108**, 639-648.

Drew, R.L.K., Hands, L.J. and Gray, D. (1997). Relating the effects of priming to germination of unprimed seeds. *Seed Science and Technology*, **25**, 537-548.

Heydecker, W. and Coolbear, P. (1977). Seed treatments for improved performance – survey and attempted prognosis. *Seed Science & Technology*, **5**, 353-425.

International Seed Testing Association. (1999). International rules for seed testing. *Seed Science and Technology*, **27**, ***Supplement***, 333pp.

Jianhua, Z. and McDonald, M.B. (1996). The saturated salt accelerated aging test for small-seeded crops. ***Seed Science & Technology***, **25**, 123-131.

Nakagawa, J. (1994). Testes de vigor baseados na avaliação das plântulas. In: *Testes de vigor em sementes*, (eds. R.D. Vieira and N.M. Carvalho), pp. 49-86, FUNEP/UNESP, Jaboticabal.

Cover Crops for Disease Control and No-Till Pumpkins – 2001

Principal Investigators:

1. Christian A. Wyenandt, Plant Pathology Dept., Ohio State University
2. Richard M. Riedel, Plant Pathology Dept., Ohio State University
3. Mark A. Bennett, Horticulture and Crop Science Dept., Ohio State University

Cover crops are used in high-input agronomic and vegetable production systems to reduce soil erosion, fungicide use, plant disease, and weeds. Cover crops have also been shown to increase soil organic matter, nitrogen availability, and moisture. Traditional cover crops, such as hairy vetch (*Vicia villosa*) and winter rye (*Secale cereale*), widely used in tomato production have been used in pumpkin (*Cucurbita pepo*) production with limited success. Traditional fall-sown cover crops, such as hairy vetch and winter rye, are typically killed by herbicide applications, mowing, or by mechanical undercutting prior to pumpkin planting. Pumpkin growers in Ohio have asked for alternative cover crops that could be spring or fall-sown and require less input than the traditional cover crops. Annual medics (*Medicago* spp.), native to Australia, have been studied as forage crops in the upper Midwest. Annual medics with their less invasive, dense, low growth habits, nitrogen fixing ability, and drought tolerance make them potential candidates as spring-sown living cover crops in pumpkin production.

Objectives:

1. Selection of spring-sown living, fall-sown (herbicide) killed, and spring-sown (herbicide) killed cover crop mulches for use in commercial pumpkin production.
2. Determine the effects of these cover crop mulch systems on pumpkin yield and aesthetic fruit quality.
3. Determine the effects of these 3 cover crop mulch systems on soil-borne fungal diseases such as fruit rot of pumpkin caused by *Fusarium spp.*
4. Introduce these cover crop systems to growers for use in commercial pumpkin production.

Planned scope of research:

Biomass production and percent ground cover determinations: Biomass production was determined by collecting and drying 1/4 m^2 quadrants from each treatment at pumpkin planting and harvest. Percent ground cover was determined by visually rating ½ m^2 ground cover at pumpkin planting and harvest.

Production, pumpkin yield and fruit quality: In Oct. 2000 fall-sown cover crop treatments of winter rye 'Wheeler' at 90 lb/A and 50 lb/A were established at research branches in Columbus, Fremont, South Charleston, and Wooster, OH. In early May 2001 spring-sown cover crop treatments of spring oat 'Amor' at 110 lb/A, annual medic 'Sephi' and 'Polygraze' at 40 lb/A were established at same sites. Plot sizes were 25' by 25'. In late May fall-sown rye plots were killed with Round-up at 4 pt/A. Planting strips (22" wide) on 10' centers were prepared in each treatment by spraying Round-up (5%) with a backpack sprayer. Fall-sown rye and spring-sown oat were laid down with a 2' wide walk-behind roller in June. In late-June Poast Plus (2 pt/A) + 24DB (2 pt/A) were sprayed on annual medic plots to control broadleaf weeds. At planting strips were tilled with a roto-tiller. Pumpkin cv. 'Magic Lantern' was seeded into the cover crop treatments in July 2001 by hand. Two seeds were planted every 2 ft. to approximate standard production practices. Seeds were established with ~8 oz. water with (10-52-10) and Admire at 2.2 oz/1000 ft. Plots were maintained with rotated applications of Bravo Ultrex @ 2.7 lb/A and Quadris @ 12.3 oz/A beginning in August. Nova 40WP @ 3.0 oz/A or Benlate 1 lb ai/A was also added to the spray program to help control Powdery Mildew. Sulfur-coated urea (39-0-0) was broadcasted @ 50 lb/A over entire plots at planting and banded at 50 lb/A at vine-tip. Pumpkins were watered with 1" drip irrigation tape throughout the growing season when necessary. At harvest all fruit from each treatment were graded according to color (orange, green) and weighed. Percentages of marketable (orange) and clean fruit were also calculated. Pumpkins were harvested during the first 3 weeks of October.

Results and Discussion:

Establishment, biomass production and % ground cover production: In general, fall-sown rye at 90 lb/A and 50 lb/A produced enough biomass to provide season long ground cover at all but one site (Table 1). Early establishment (ie. prior to hard freezes) in the fall is critical to the success of winter rye and hairy vetch as cover crop mulches. Spring-sown oat at 110 lb/A planted in early May provided excellent early to mid-season ground cover. Oat tended to breakdown much quicker than fall-sown rye and its ability to provide ground cover, suppress weeds, and conserve soil moisture decreased much quicker than rye during the growing season. Both annual medics established well when planted in early May. Spring-sown annual medic 'Sephi' provided excellent season long ground cover whereas, 'Polygraze' provided early, but failed to provide season long ground cover due to early senescence from summer heat, spider mites, and powdery mildew. 'Sephi' continued to grow through the summer at 4 of 6 sites, nutsedge and spider mites caused problems at 2 sites.

Pumpkin yield and fruit quality: Pumpkin yields in bare soil/ fungicide treatment plots were much higher than the bare soil / no fungicide treatments in the presence of powdery mildew (Table 1). Yields were similar with no pressure from powdery mildew (S. Charleston). Yields from fall-sown rye plots were comparable to bare soil plots. Yield from spring-sown oat plots were slightly lower than the bare soil and fall-sown rye plots, but much higher than the annual medic plots. Even with the adoption of strip tillage, yields in the annual medic plots were extremely poor. This may be due to continued competition and/or allelopathic chemicals released from the living mulch. Fruit cleanliness in bare soil plots ranged from extremely low (16%) to high (42%) at research farm sites. Fruit cleanliness was much higher in fall-sown rye plots (51– 81 %). Spring oat plots provided intermediate cleanliness which ranged from 41-80% at the different farm sites. Fruit cleanliness in annual medic plots ranged from 60 to 94% depending on the cultivar and the site.

Effects of living and spring-killed cover crops on fruit rot of pumpkin: In order to determine the effects of cover crop on Fusarium fruit rot, 3 cover crop treatments were established in May 2001 at two commercial field sites in Wayne Co., OH. The treatments included a bare soil (no fungicide), bare soil (fungicide), spring-sown oat (herbicide killed) @ 110 lb/A, annual medic 'Sephi' (living) @ 40 lb/A, and annual medic 'Polygraze' (living) @ 40 lb/A. Cover crop establishment and production practices were followed as described above. Each site had been used for pumpkin production prior to the 2001 growing season and each had past history of Fusarium fruit rot (FFR). Biomass, percent ground cover, pumpkin yield, and fruit cleanliness were characterized as previously described. At harvest individual pumpkin fruit from each treatment were also examined for FFR symptoms. Unfortunately, FFR was not a problem in the locations of our plots on the on-farm sites. Yields and fruit quality at the on-farm sites were consistent with our findings at the research farm sites (data not shown).

Overall, our findings continue to show that fall-sown rye can be successfully incorporated into pumpkin production in Ohio although integration and success will depend on fall-planting date, lbs/A planted, spring kill date, and method of pumpkin planting. We find that a strip tillage system may allow for easier pumpkin planting as well as offer some leeway in the window of opportunity for spring kill. Too much rye biomass has often been a problem. Spring-oat when planted at a high rate (110 lb/A) can also be successfully incorporated into a strip-tillage pumpkin production system. Planting a cover crop such as oat in the spring alleviates some of the problems of a fall-sown cover crop such as having a field free for planting and helps to avoid some of the weather contingencies necessary for a successful cover crop. Although oat will not produce as much biomass as a fall-sown rye, its growth habit makes it much easier to kill with herbicides, as well as, having a much greater window of opportunity for kill. Spring-sown annual medics when left as living mulches in a strip-tillage system with drip irrigation still cause reduced yields and later maturity in pumpkin production. In 2002 our research will continue with the same type of strip tillage production systems. One of our objectives will be to determine the exact effects annual medics have on pumpkin growth in order for us to successfully incorporate them into pumpkin production.

Table 1. Cover crops for disease control and no-till pumpkins - 2001.

Waterman Agricultural and Natural Resources Laboratory, Columbus, OH

Treatment	Total Fruit	# Orange	# Green	Kg Orange wt	Kg Green wt	Kg Rot wt	Kg Total wt	% Orange	% Clean	% Ground Cover (1/2 m) Planting	% Ground Cover (1/2 m) Harvest	Biomass Dry Wt.(gr) (1/4 m) Planting	Biomass Dry Wt.(gr) (1/4 m) Harvest
Bare Soil -Fungicide	38.3	24.3	14.0	116.9	32.4	0.5	149.3	65	28	0	0	0.0	0.0
Bare Soil -No Fungicide	21.5	13.0	8.5	61.3	18.3	0.0	79.6	59	16	0	0	0.0	0.0
W. Rye - Wheeler (90 lb/A)	35.3	23.3	10.0	128.0	25.1	0.0	153.0	70	83	89	84	126.0	65.3
W. Rye - Wheeler (50 lb/A)	38.0	27.3	10.7	128.8	22.6	0.0	151.3	72	74	83	78	127.2	63.6
An. Medic -Sephi (40 lb/A)	25.8	16.8	9.0	49.6	18.6	0.9	68.2	68	60	74	78	29.1	79.1
An. Medic - Polygraze (40 lb/A)	22.5	16.5	6.0	56.6	8.6	0.0	65.2	72	63	50	0	6.0	0.0
Spr. Oat 'Amor' (110 lb/A)	32.8	23.0	9.8	102.0	21.9	0.7	123.9	71	41	79	30	53.7	28.0

Vegetable Crops Branch, Fremont, OH

Treatment	Total Fruit	# Orange	# Green	Kg Orange wt	Kg Green wt	Kg Rot wt	Kg Total wt	% Orange	% Clean	% Ground Cover (1/2 m) Planting	% Ground Cover (1/2 m) Harvest	Biomass Dry Wt.(gr) (1/4 m) Planting	Biomass Dry Wt.(gr) (1/4 m) Harvest
Bare Soil -Fungicide	32.0	23.8	8.3	144.5	24.2	0.6	169.0	74	25	0	0	0.0	0.0
Bare Soil -No Fungicide	26.3	14.5	11.8	90.2	32.2	0.4	122.3	50	26	0	0	0.0	0.0
W. Rye - Wheeler (90 lb/A)	32.5	20.3	12.3	130.1	37.0	0.7	167.2	63	86	86	87	79.9	51.7
W. Rye - Wheeler (50 lb/A)	34.8	23.8	11.0	157.2	31.3	0.5	188.5	69	75	80	70	60.3	54.3
An. Medic -Sephi (40 lb/A)	25.3	9.0	16.3	47.5	33.8	0.0	81.3	35	94	80	100	24.4	94.9
An. Medic - Polygraze (40 lb/A)	28.8	16.0	12.8	79.9	28.6	0.0	109.0	56	60	80	42	20.8	14.2
Spr. Oat 'Amor' (110 lb/A)	28.3	22.3	6.0	139.2	17.5	0.5	156.6	79	67	90	80	74.3	52.2

Western Branch, South Charleston, OH

Treatment	Total Fruit	# Orange	# Green	Kg Orange wt	Kg Green wt	Kg Rot wt	Kg Total wt	% Orange	% Clean	% Ground Cover (1/2 m) Planting	% Ground Cover (1/2 m) Harvest	Biomass Dry Wt.(gr) (1/4 m) Planting	Biomass Dry Wt.(gr) (1/4 m) Harvest
Bare Soil -Fungicide	32.0	24.3	7.8	143.2	30.7	1.4	173.9	62	42	0	0	0.0	0.0
Bare Soil -No Fungicide	36.0	23.5	12.5	137.1	41.7	0.9	178.4	61	26	0	0	0.0	0.0
W. Rye - Wheeler (90 lb/A)	28.0	14.8	13.3	93.4	58.4	1.4	151.9	50	70	71	65	46.3	53.6
W. Rye - Wheeler (50 lb/A)	34.3	22.3	12.0	129.0	47.1	3.0	176.7	64	51	55	50	69.2	51.9
An. Medic -Sephi (40 lb/A)	35.0	22.3	12.8	117.2	32.2	1.6	149.4	66	60	84	12	69.2	19.7
An. Medic - Polygraze (40 lb/A)	25.0	14.3	10.8	78.8	30.0	0.2	108.9	57	70	90	2	31.9	5.5
Spr. Oat 'Amor' (110 lb/A)	32.5	19.5	13.0	116.7	44.4	1.6	161.1	59	48	84	50	62.0	38.9

OARDC, Snyder Farm, Wooster, OH

Treatment	Total Fruit	# Orange	# Green	Kg Orange wt	Kg Green wt	Kg Rot wt	Kg Total wt	% Orange	% Clean	% Ground Cover (1/2 m) Planting	% Ground Cover (1/2 m) Harvest	Biomass Dry Wt.(gr) (1/4 m) Planting	Biomass Dry Wt.(gr) (1/4 m) Harvest
Bare Soil -Fungicide	44.8	29.8	15.0	177.1	36.7	1.0	213.8	68	39	0	0	0.0	0.0
Bare Soil -No Fungicide	39.0	27.5	11.5	152.1	24.8	1.5	176.8	71	31	0	0	0.0	0.0
W. Rye - Wheeler (90 lb/A)	46.3	35.5	10.8	211.9	23.7	0.6	235.7	78	67	80	72	75.0	57.1
W. Rye - Wheeler (50 lb/A)	45.3	33.5	11.8	177.4	30.2	0.3	207.6	74	60	75	60	51.8	52.3
An. Medic -Sephi (40 lb/A)	40.5	21.0	19.5	72.1	26.8	0.2	98.9	53	87	96	83	60.9	71.4
An. Medic - Polygraze (40 lb/A)	44.3	23.8	20.5	84.1	37.3	0.6	121.4	53	76	88	32	46.4	30.3
Spr. Oat 'Amor' (110 lb/A)	50.5	37.3	14.5	192.2	29.9	0.5	222.1	74	80	94	67	86.9	51.2

Weather Data - 2001

Vegetable Crops Branch, Fremont, OH

Month	Average Min. Temperature (°F)	Average Max. Temperature (°F)
April	37.5	62.5
May	49.5	72.8
June	57.4	80.2
July	59.2	84.4
August	58.7	83.3
September	48.3	73.6
October	42.0	62.8

Month	Rainfall (inches)	Normal Rainfall Average (inches)
April	3.40	3.40
May	3.69	3.50
June	1.62	4.00
July	3.62	3.80
August	2.88	3.30
September	3.72	3.00
October	6.45	2.50

Weather Data - 2001

Waterman Ag & Natural Resources Laboratory, Columbus, OH

Month	Average Min. Temperature (°F)	Average Max. Temperature (°F)
April	44.1	68.2
May	52.9	74.5
June	59.9	81.9
July	63.5	84.7
August	65.5	85.4
September	not available	not available
October	not available	not available

Month	Rainfall (inches)	Normal Rainfall Average (inches)
April	4.02	3.07
May	7.48	4.40
June	3.43	4.50
July	3.65	4.70
August	1.61	3.70
September	not available	not available
October	not available	not available

This page intentionally blank.

This page intentionally blank.

This page intentionally blank.